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January 6, 2011

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Attn: Michelle Kerr

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Site Remediation Section
Minnesota Pollution Control Agency
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St. Paul, Minnesota 55155
Attn: Nile Fellows

Subject: United States of America, et al. vs. Reilly Tar & Chemical Corporation, et al.
File No. Civ. 4-80-469
2006 Five-Year Review: Vertical Migration

Dear Project Leaders,

During our October 29, 2010 meeting in St. Louis Park for the 2011 five year review, we looked at the 2006 report and its list of "Recommendations and Follow-Up Actions". This letter responds to item number six on that list regarding vertical gradients that may influence groundwater flow and contaminant distribution in the St. Louis Park aquifer system. To ensure a common understanding of this issue the alternative conceptual model presented in this letter is a result of discussions with Peter Rzepecki. Peter is with AECOM and in 2006 was with STS who was retained by MPCA to assist with the preparation of the 2006 Five Year Review. Peter has also been instrumental in the MPCA's recent modeling analyses for St. Louis Park and the Edina VOC problem.

According to Peter, the 2006 recommendation to characterize vertical gradients was based on filling in holes in the conceptual model for contaminant migration from shallow aquifers to the deeper aquifers. In particular, this issue revolved around the possibility that vertical gradients may have been the driving force for PAH and VOC to migrate from high concentrations in areas of the Drift and Platteville Aquifers into the Prairie du Chien – Jordan Aquifer. The conceptual model in 2006 assumed that contaminants were transported downward through the Glenwood Shale and basal St. Peter confining layers. The following discussion provides information on water level data that have been collected to measure vertical gradients and provides an alternate conceptual model – namely, leaky multi-aquifer wells were responsible for allowing shallow contaminants to migrate to deeper aquifers.

Water Level Data Demonstrating Vertical Gradients

Figure 1 presents continuous water level data for the various aquifers monitored on a routine basis. Hydrographs of wells completed in the Drift/Platteville, St. Peter, Prairie du Chien/Jordan, Ironton/Galesville, and Mt. Simon/Hinckley shown in Figure 1 demonstrate significant hydraulic head differences between these aquifers. This relationship of lower head elevations in successively deeper aquifers has been identified as a characteristic of the hydrogeology of the Twin Cities Basin in prior studies (e.g., see Norvitch, R.F., Ross, T.G., and Brietkrietz, A. 1972. Water Resources Outlook for the Minneapolis-St. Paul Metropolitan Area, Minnesota).

Water level monitoring in the various aquifers in St. Louis Park has confirmed the presence of downward vertical gradients across the Glenwood shale and basal St. Peter confining layers. For example, wells W425 and W409 in the Drift and St. Peter Aquifers, respectively, have been equipped with pressure transducers for the past several years. Figure 2 shows the locations of these wells and Figure 3 shows an example hydrograph that demonstrates the hydraulic head difference at this location. The average head difference at this location is approximately 13 feet based on these measurements. Other pairs of Drift and St. Peter Aquifer wells produce similar results. The low vertical hydraulic conductivity of the Glenwood Shale allows water to leak through at a low rate, thus separating the St. Peter Aquifer from overlying groundwater. Retardation effects would reduce the rate at which VOC or PAH would flow across the shale layers compared to groundwater.

The presence of significant vertical gradients across the Glenwood Shale is a measure of the effectiveness of the shale as a confining layer. Groundwater does flow in response to pressure gradients, but it also takes the path of least resistance. Given the relative horizontal and vertical permeabilities of the strata involved, groundwater flow in the Drift-Platteville Aquifer is primarily horizontal.

Vertical gradients have also been measured across the basal St. Peter Formation where horizontal shale layers are interbedded with sand. Figure 4 presents hydrographs of wells W409 and W23 completed in the St. Peter and Prairie du Chien – Jordan aquifers, respectively. Approximately 50 feet of hydraulic head differences are observed in this area. This indicates that shale layers in the basal St. Peter serve as a confining layer in this area. Similar to the Drift and Plattevillle aquifers, groundwater flow is predominantly horizontal in the St. Peter aquifer.

Alternate Conceptual Model

The USGS Water Supply Paper 2211 explained the hydraulic conditions in a multi-aquifer well. Figure 5 is reproduced from that report and indicates that water flows out of the upper aquifer into the lower aquifer interconnected by an uncased or ungrouted well. At the Reilly Site, well W23 was found to be a significant example of a multi-aquifer well. Based on the history of contamination at the site, and the subsequent pumping history of St. Louis Park municipal wells, it is probable that most of the PAH contamination in the Prairie du Chien - Jordan Aquifer migrated via multi-aquifer flow in well W23.

Down-hole flow in well W23 allowed for a much more rapid downward migration of PAH from the Reilly Site as compared to natural vertical flow paths through the aquifers and confining layers. The first St. Louis Park municipal well was drilled in 1932 - only 15 years after Reilly began operations in St. Louis Park in 1917. After two weeks of pumping, a creosote taste and odor problem was noticed in the municipal well water suggesting that migration from the ground surface and/or from shallow

aquifers had occurred within only 15 years. This is faster than one would expect from migration through natural vertical flow paths.

This conceptual model of down-hole flow in multi-aquifer wells better explains the historical progression of the spread of contamination from the Reilly Site, and also explains why the PAH plume in the St. Peter aquifer is smaller than would be expected if vertical migration through the geologic strata were occurring. The vertical gradients measured throughout St. Louis Park indicate that very little groundwater flows downward through the confining layers.

Based on this analysis and the prior completion of multi-aquifer well investigations in accordance with CD-RAP Section 10, the City believes that no further follow-up actions are required to address PAH contaminant spreading due to vertical gradients.

We look forward to any questions or comments you may have on this topic.

Yours sincerely,

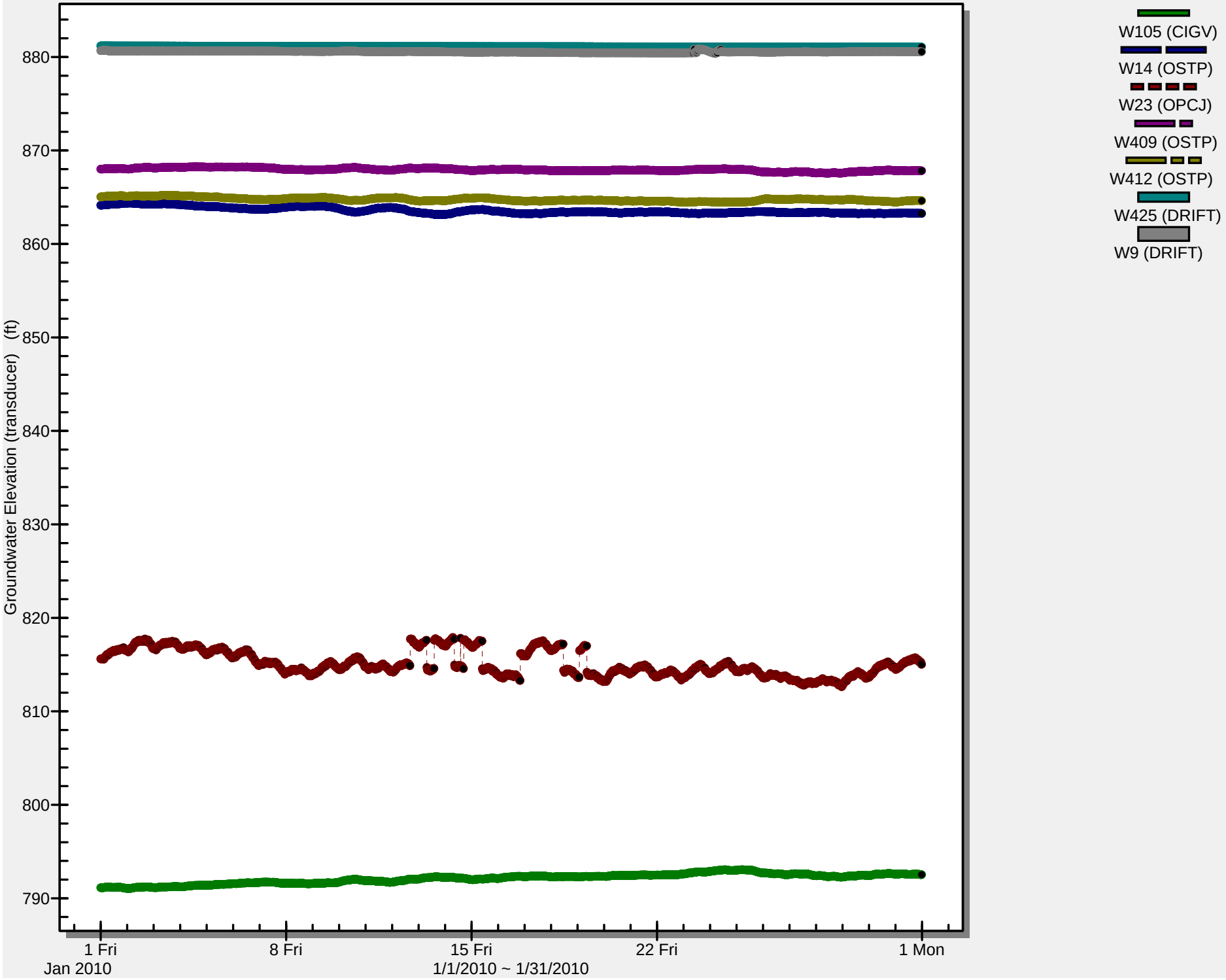
William M. Gregg

William M. Gregg
Project Leader
City of St. Louis Park

cc. Scott Anderson

Figure 1 - Hydrograph of Selected Wells - January 2010

Wells W105, W23, W14, W409, W425, and W9



Map adapted from USDA FSA NAIP Orthophoto, 2010: Hennepin County, Minnesota.

Explanation

- Monitoring Well (DRIFT)
- Monitoring Well (OSTP)
- Reilly Pumping Well (OPCJ)

N
W E
S

Site Location

0 250 Feet
1 inch = 250 feet

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FIGURE 2
WELL LOCATIONS MAP

Reilly Site
St. Louis Park, MN

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Figure 3 - Hydrograph of Wells W409 and W425

January 2010

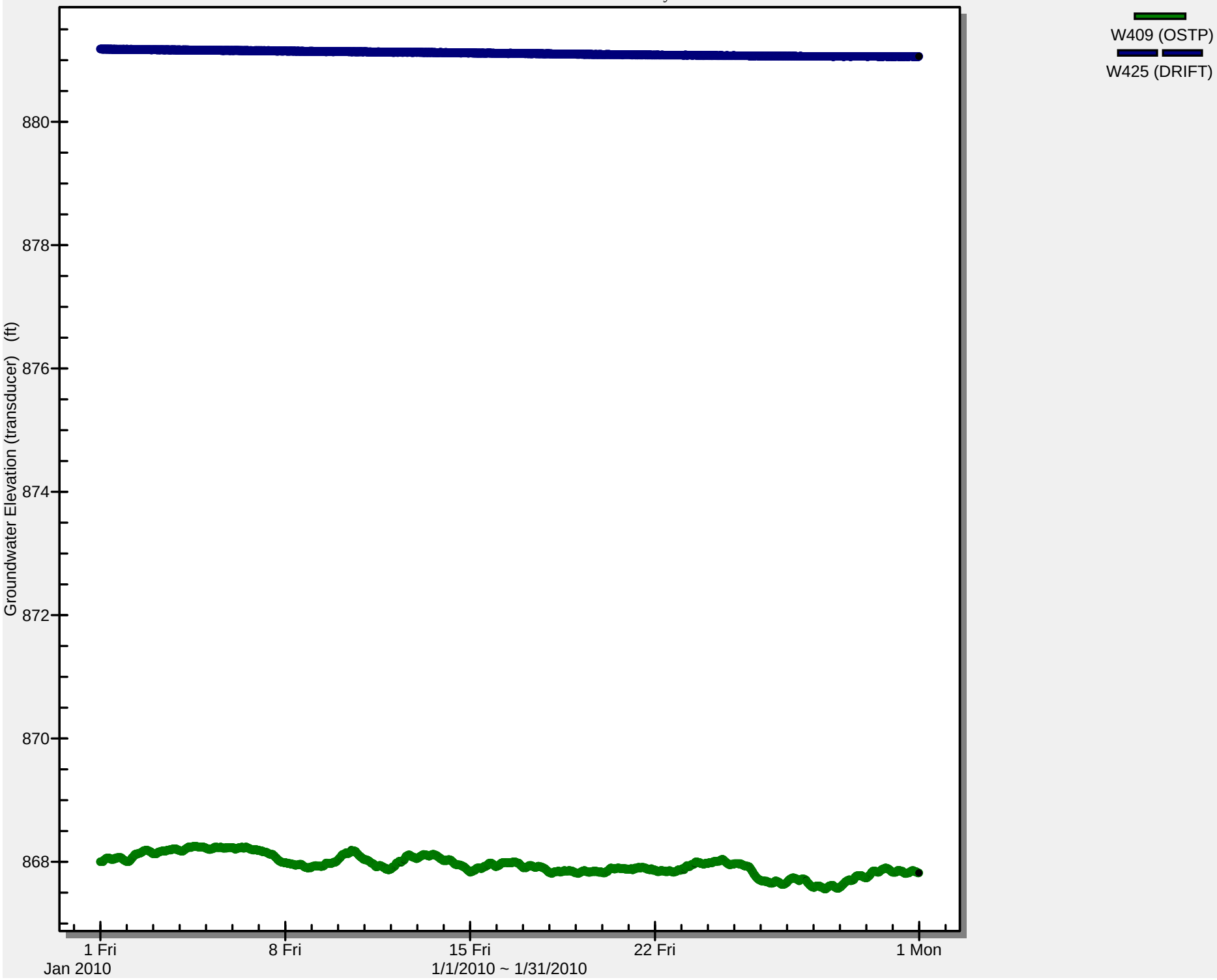
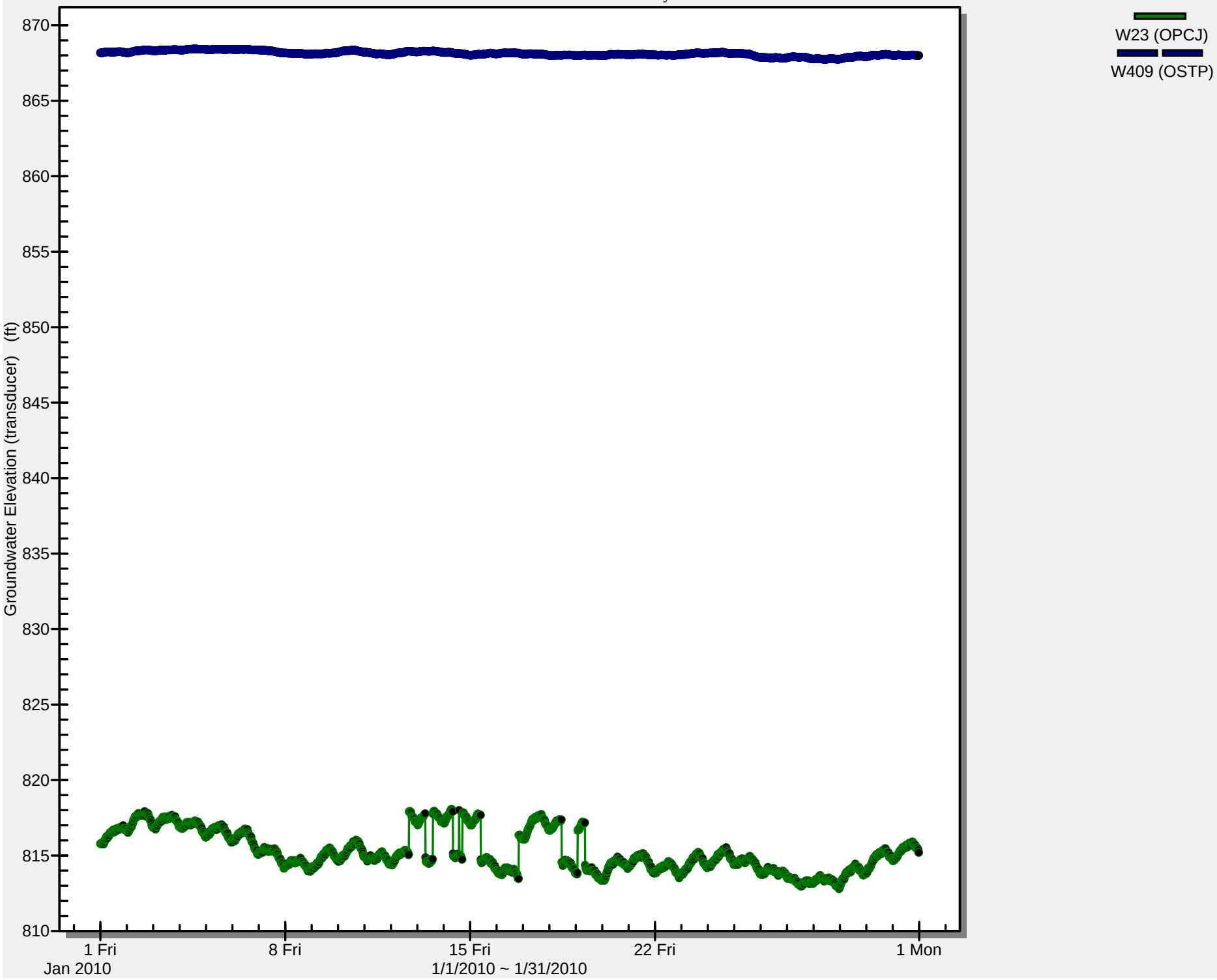
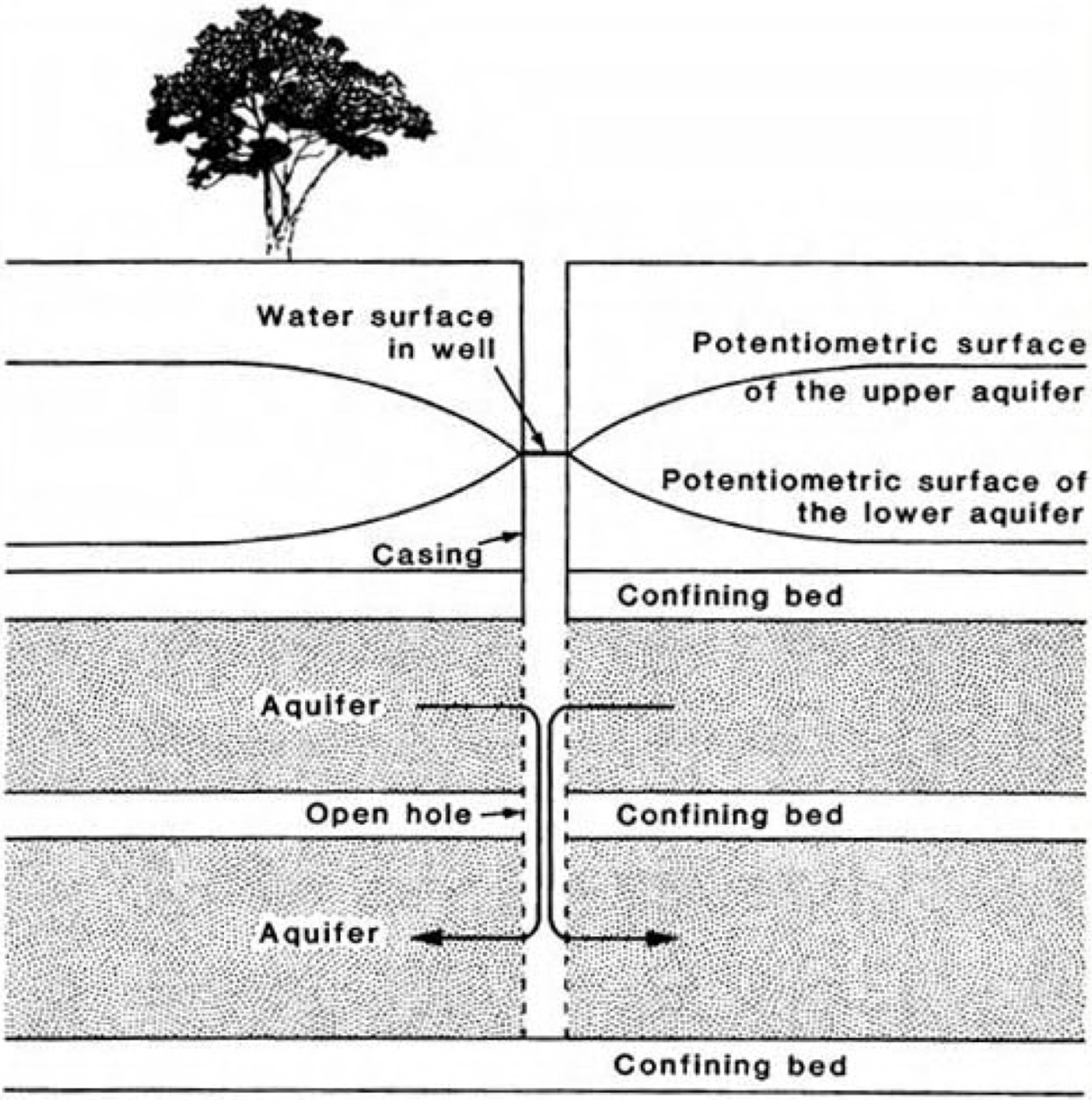


Figure 4 - Hydrograph of Wells W409 and W23

January 2010





"Figure 14. Schematic hydrologic section showing a well connecting two confined aquifers, flow through the well bore, and the effects of this flow on the potentiometric surfaces of the two aquifers."

Adapted from:
Hult, M.F., and Schoenberg, M.E., 1984, Preliminary evaluation of ground-water contamination by coal-tar derivatives, St. Louis Park area, Minnesota: U.S. Geological Survey Water-Supply Paper 2211, 53 p.

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FIGURE 5
FLOW THROUGH A WELL BORE

Reilly Site
St. Louis Park, Minnesota

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